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Floods and droughts: a multivariate perspective on hazard estimation

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Floods and droughts are often studied from a univariate perspective, which ignores their multivariate nature and can lead to risk under- or overestimation. The multivariate nature of hydrological extremes makes them particularly impactful, e.g. when they affect large areas or several components of the hydrological cycle, and should be considered when deriving frequency and magnitude estimates for hydraulic design and adaptation. However, studying multivariate extremes is challenging because different variables are related and because they are even less abundant in observational records than univariate extremes.
In this talk, I discuss different types of multivariate hydrological extremes and their dependencies including spatially co-occurring flood events, floods described by peak and volume, or droughts characterized by deficit and duration. I present different strategies to describe and model multivariate extremes, to assess their hazard potential, and to increase sample size – for example, the openly available R-package PRSim that stochastically simulates streamflow and hydrological extremes at multiple locations. I illustrate potential applications of some strategies using different large-sample datasets ranging from sets of alpine catchments in Switzerland to sets of hydro-climatologically diverse catchments in the United States and on the European continent. The strategies discussed enable a multivariate perspective in hydrological hazard assessments, which allows us to derive more comprehensive risk estimates than the classical univariate perspective commonly applied.